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UNIVERSITY OF MISSOURI,
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"WORK IS VICTORY."





"*WORK IS VICTORY.*"





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Twenty=Third Annual Catalogue

of the

School of Mines *and* Metallurgy

of the

University of the State of Missouri,

Rolla, Missouri.

With an

Outline of the Courses of Study

and the

Plan of Instruction.

1893.

Columbia, Missouri :
E. W. Stephens, Publisher and Binder,
1893.

Calendar.

1893.

June 9, Friday, 10 A. M., Annual Commencement.
Sept. 18, Monday, 10 A. M., Entrance Examinations.
Sept. 19, Tuesday, . . . First Term Begins.
November 30, Thursday, . . . Thanksgiving Holiday.
December 22, Friday, . . . Christmas Holidays Begin.

1894.

January 2, Tuesday, . . . Exercises Resumed.
January 22, Monday, . . . Mid-Year Examinations Begin.
January 27, Saturday, . . . Mid-Year Examinations Close.
January 30, Tuesday, . . . Second Term Begins.
February 22, Tuesday, . . . Washington's Birthday Holiday
May 28, Monday, . . . Final Examinations Begin.
June 5, Tuesday, . . . Final Examinations Close.
June 7, Thursday, 10 A. M. Annual Commencement.

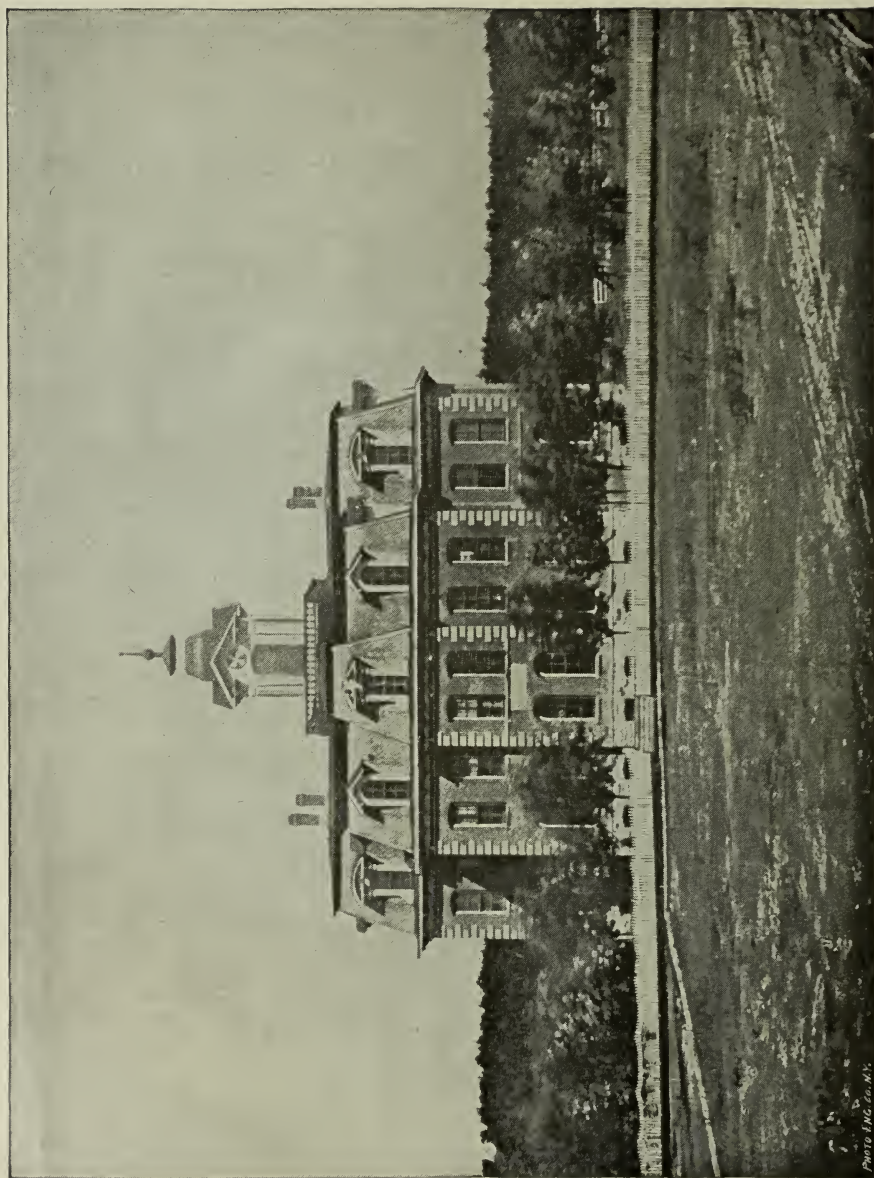


PHOTO BY J. M. CO. N.Y.

COLLEGE BUILDING.

Board of Curators

of the

University of the State of Missouri.

Term expires January 1, 1895.

BUSHROD MALCHUS DILLEY,	. . .	Hamilton.
GARDINER LATHROP,	. . . . .	Kansas City.
BENJAMIN ROSS CAUTHORN,	. . .	Mexico.

Term expires January 1, 1897.

GIDEON FRANKLIN ROTHWELL,	. .	Moberly.
JOHN RICE RIPPEY,	. . . . .	Glenwood.
CALVIN MILTON WOODWARD,	. . .	St. Louis.

Term expires January 1, 1899.

EWING YOUNG MITCHELL,	. . .	Rolla.
ROBERT BURRETTE OLIVER,	. . .	Jackson.
JOHN SCOTT CLARKSON,	. . .	Columbia.

OFFICERS OF THE BOARD.

GIDEON FRANKLIN ROTHWELL,	. .	President.
BUSHROD MALCHUS DILLEY,	. . .	Vice-President.
ROBERT BEVERLY PRICE,	Treasurer.
JERRE GLENN BABB,	Secretary.
JOSEPH BEELER DOUGLASS,	Land Commissioner.

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of the

School of Mines and Metallurgy.

GENERAL E. Y. MITCHELL, . . . Rolla.
JOHN S. LIVESAY, . . . Rolla.
JUDGE C. C. BLAND, . . . Rolla.

OFFICERS OF THE COMMITTEE.

EWING Y. MITCHELL, . . . Chairman.
DAVID W. MALCOLM, . . . Treasurer.
THOMAS M. JONES, . . . Secretary.

Faculty of Instruction.

RICHARD H. JESSE, L. L. D.. . *President of the University.*

ELMO G. HARRIS, C. E. (University of Virginia),
**Director and Professor of Engineering.*

WALTER BUCK RICHARDS, M. A. (University of Virginia),
Professor of Mathematics.

AUSTIN LEE MCRAE, S. D. (Harvard University),
Professor of Physics.

WILLIAM H. SEAMON, B. A. S. (University of Virginia),
Professor of Chemistry and Metallurgy.

THOMAS LEWIS RUBEY, A. M. (University of Missouri),
Secretary and Instructor in Academic Department.

PAUL J. WILKINS, B. S. (Michigan A. and M. College),
Instructor in Academic Department.

THOMAS GRAYSON POATS,
Instructor in Drawing and Shop-work.

DANIEL C. JACKLING, B. S. (Missouri School of Mines,
Assistant in Chemistry and Metallurgy.

CLIFTON B. SPENCER, (Missouri School of Mines, '93),
Assistant in Engineering and Mathematics.

*Walter B. Richards will be director after July 1, 1893.

Administrative Officers.

RICHARD H. JESSE,
President of the University.

*ELMO G. HARRIS,
Director of the School of Mines.

THOMAS L. RUBEY,
Librarian and Secretary of the Faculty.

*Walter B. Richards will be director after July 1, 1893.

Introductory Statement.

THE School of Mines and Metallurgy is an Institute of Technology, and constitutes one of the Colleges which, taken together, form the University of the State of Missouri. It was founded in 1870, when Missouri made provisions for accepting the 330,000 acres of public land donated to her by the General Government by an Act of Congress, approved July 2, 1862, entitled, "An act donating lands to the several States and Territories which may provide Colleges for the benefit of Agriculture and the Mechanic Arts." Three-fourths of this fund was used in establishing the Agricultural and Mechanical College at Columbia and the other fourth in the establishment of the School of Mines and Metallurgy at Rolla.

The proceeds from the sale of this land, up to date, amounts to \$317,000, which is invested in State certificates of indebtedness, bearing 5 per cent. interest.

By an Act of Congress, approved August 30, 1890—commonly known as the "Morrill bill"—the General Government donated to each State and Territory the sum of \$15,000 for the year 1889-90, which was to be increased by \$1,000 a year until it should reach the sum of \$25,000, which should remain an annual appropriation. Missouri gives one-sixteenth of this fund to Lincoln Institute at Jefferson City, one-fourth of the remainder to the School of Mines and the balance to the Agricultural and Mechanical College.

By virtue of an act of the State Legislature, approved March 26, 1891, the "direct tax," amounting to \$646,958.33, refunded to Missouri by the General Government was given to the State University as a permanent endowment fund. This has been invested in a State certificate of indebtedness, bearing 5 per cent. interest. The School of Mines receives one-fifth of this income.

The Government of the School of Mines.

The following State Statutes relative to the School of Mines are self-explanatory :

University Established.—A University is hereby instituted in this State, the government whereof shall be vested in a Board of Curators. (R. S. 1889, Sec. 8692.)

Corporate Name.—The University is hereby incorporated and created a body politic, and shall be known by the name of “The Curators of the University of the State of Missouri,” and by that name shall have perpetual succession, power to sue and be sued, complain and defend in all courts, to take, purchase and hold, to sell, convey and otherwise dispose of lands and chattels. (R. S. 1889, Sec. 8693.)

Curators Number of.—The Board of Curators of the State University shall hereafter consist of nine members who shall be appointed by the Governor, by and with the advice and consent of the Senate. *Provided*, that not more than one person shall be appointed upon said Board from the same Congressional District, and no person shall be appointed a Curator who shall not have attained the age of 21 years, or who shall not be a citizen of the United States, and who shall not have been a resident of the State of Missouri two years next prior to his appointment. (R. S. 1889, Sec. 8694.)

Agricultural College and School of Mines Established.—There is hereby established the Agricultural and Mechanical College and a School of Mines and Metallurgy, provided for by the grant of the Congress of the United States, as a distinct department of the University of the State of Missouri. (R. S. 1889, Sec. 8738.)

Objects of These Colleges.—The leading objects of said Colleges shall be to teach such branches as are related to agriculture and the mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (R. S. 1889, Sec. 8739.)

Right to Confer Degrees.—The Agricultural and Mechanical College and the School of Mines and Metallurgy shall have power to confer degrees suitable to their designs and courses of studies. (R. S. 1889, Sec. 8743.)

Exemptions from Taxation.—The Agricultural and Mechanical College and the School of Mines and Metallurgy, and the lands, stock, apparatus and furniture, and all other property belonging to the same, shall be exempt from State, County and Municipal taxation. (R. S. 1889, Sec. 8764.)

Professorship of Geology.—The School of Mines and Metallurgy shall be empowered to utilize all implements, instruments, charts, specimens, etc., and the Board of Curators may establish, when they deem proper, a Professorship of Geology, said geologist to supervise the geological surveys that may be made by the School of Mines and Metallurgy. *Provided*, that nothing in this chapter shall be so construed as to authorize the removal of the specimens now in Washington University of St. Louis. (R. S. 1889, Sec. 8765.)

Academic Course of Study, etc.—That the obligations of the State to the General Government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the State University shall prescribe and adopt a liberal Academic Course of study to be taught in the College of Mines and Metallurgy, located at Rolla, in addition to the courses now taught in said school, and may confer the degree of Bachelor of Science upon all students who shall complete said course in said school to the satisfaction of the Faculty thereof. (Laws 1885, p. 25.)

Treasurer of School of Mines.—There is hereby created the office of Treasurer of the School of Mines and Metallurgy, located in the County of Phelps, whose duty it shall be to receive, keep and disburse all moneys belonging to said School of Mines and Metallurgy, the money donated and the proceeds of the bonds issued by Phelps County for building and other purposes of said school, the proceeds of the lands donated to the Board of Curators of the State University and conveyed to the State of Missouri for the uses and purposes of said school, all moneys which shall be appropriated or apportioned for the purpose of said school, including one-fourth of the income arising from the agricultural and mechanical land fund, and all other money which may belong exclusively to said school for building or for any other purpose. He shall have the custody of the said bonds issued by Phelps County, and shall, under the direction of the Board of Curators and in accordance with the provisions of law, sell the same or borrow money and hypothecate said bonds for the purpose for which they were issued; and the said Treasurer shall perform all customary acts pertaining to his office under the direction of the Board of Curators, and make report of the same at the annual meetings of the Board. (R. S. 1889, Sec. 8766.)

To be Appointed by Curators.—The Governor shall appoint the Treasurer for the School of Mines and Metallurgy, who shall hold his office until the annual meeting of the board of Curators, and thereafter he shall be appointed by the Board, and hold his office during the pleasure of the Board. (R. S. 1889, Sec. 8767.)

Duty of Treasurer of University.—The Treasurer of the Board of Curators shall pay over to the Treasurer of the School of Mines and Metallurgy, as soon as he shall be appointed and his bond approved, and at all times hereafter, all moneys, bonds and all property whatsoever in his hands, which have been donated or which have been or hereafter may be appropriated or apportioned, or in any manner belonging to said school for its support or for any other purpose. (R. S. 1889, Sec. 8769.)

Selling Liquor to Students, How Punished.—Any person who shall knowingly sell, give or in any manner dispose of, any intoxicating liquors to any student of the State University, or of any school, college or academy in this State, shall be guilty of a misdemeanor, and shall, upon conviction, be punished by a fine of not less than \$40 or more than \$400, or by imprisonment in the County jail not less than three months nor more than one year, or by both such fine and imprisonment. *Provided*, that it shall be lawful for druggists to sell or give such liquors to any student upon the written prescription of a regular practicing physician in good standing, or upon the written order of the President of the University or College, or principal of the School or Academy, at which such student may be in attendance, or by the written order or consent of the parent or guardian of such student. *Provided*, that nothing in this section shall be so construed as to apply to any Mercantile or Business College. (R. S. 1889, Sec. 8737.)

Plan of Instruction.

The course of instruction at this school deals in detail with the principles and the practice of Engineering, with special reference to Mining Engineering, Civil Engineering, Mechanical Engineering, Chemistry and Metallurgy, Mathematics, Physics and Electricity. The classes are instructed by recitations, lectures, laboratory work and field practice. While a theoretical knowledge of each subject is required, great importance is attached to laboratory work and field practice as a source of mental training as well as a preparation for active pursuits. Each student is expected to spend a large proportion of his time in the laboratories, drawing rooms or in the field. In laboratory work, while a certain standard of excellence must be attained by all, the class system is not adopted. Each student, working independently of others, advances as rapidly as possible.

THESIS.—At the close of the year each member of the Senior Class presents to the Faculty a paper in which he records some independent investigation, on a subject congenial to his tastes and included in the scope of his course. These theses, together with all drawings to illustrate them, are preserved in the library of the School.

Provisions are now made for the following technical courses:

- I. MINING ENGINEERING.
- II. CIVIL ENGINEERING.
- III. MECHANICAL ENGINEERING.
- IV. CHEMISTRY AND METALLURGY.
- V. MATHEMATICS AND PHYSICS.

For the satisfactory completion of any one of these courses the degree of Bachelor of Science will be given.

Applicants to enter the Freshman class will be examined in Arithmetic, Algebra (to quadratics).

The Freshman year is the same for the Engineering courses; the election being made at the beginning of the Sophomore year.

If on examination an applicant is found proficient in the studies assigned to the Freshman year, he will be permitted to enter the Sophomore class.

In addition to the regular courses outlined above, provisions are made for the following special courses:

- I. ASSAYING.
- II. SURVEYING.
- III. ELECTRICITY.

For the satisfactory completion of these subjects a Certificate of Proficiency will be given.

FRESHMAN YEAR.

Hours for Lecture.	Course in Mining Engineering.	No. per week.	Course in Civil Engineering.	No. per week.	Course in Mechanical Engineering.	No. per week.	Course in Chemistry and Metallurgy.	No. per week.	Course in Mathematics and Physics.	No. per week.
First Term 18 Weeks.										
8½-9½	English.....	3	English.....	3	English.....	3	English.....	3	English.....	3
9½-10½	Higher Algebra.....	5	Higher Algebra.....	5	Higher Algebra.....	5	Higher Algebra.....	5	Higher Algebra.....	5
10½-11½	Elementary Mechanics.....	2	Elementary Mechanics.....	2	Elementary Mechanics.....	2	Elementary Mechanics.....	2	Elementary Mechanics.....	2
11½-12½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2-3	Plane Geometry.....	4	Plane Geometry.....	4	Plane Geometry.....	4	Plane Geometry.....	4	Plane Geometry.....	4
3-4	Elementary Physics.....	3	Elementary Physics.....	3	Elementary Physics.....	3	Elementary Physics.....	3	Elementary Physics.....	3
3-5	Shop Practice.....	2	Shop Practice.....	2	Shop Practice.....	2	Shop Practice.....	2	Shop Practice.....	2
Second Term 18 Weeks.										
8½-9½	English.....	3	English.....	3	English.....	3	English.....	3	English.....	3
9½-10½	Higher Algebra.....	5	Higher Algebra.....	5	Higher Algebra.....	5	Higher Algebra.....	5	Higher Algebra.....	5
10½-11½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11½-12½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2-3	Solid Geometry.....	4	Solid Geometry.....	4	Solid Geometry.....	4	Solid Geometry.....	4	Solid Geometry.....	4
3-4	Elementary Chemistry.....	3	Elementary Chemistry.....	3	Elementary Chemistry.....	3	Elementary Chemistry.....	3	Elementary Chemistry.....	3
3-5	Shop Practice.....	2	Shop Practice.....	2	Shop Practice.....	2	Shop Practice.....	2	Shop Practice.....	2

SOPHOMORE YEAR.

Hours for Lecture.	Course in Mining Engineering.	No. per week.	Course in Civil Engineering.	No. per week.	Course in Mechanical Engineering.	No. per week.	Course in Chemistry and Metallurgy.	No. per week.	Course in Mathematics and Physics.	No. per week.
First Term 18 weeks.										
8½-9½	General Chemistry..	3	General Chemistry..	3	General Chemistry..	3	General Chemistry..	2	General Chemistry..	3
9½-10¼	Descriptive Geometry.....	2	Descriptive Geometry.....	2	Descriptive Geometry.....	2	Descriptive Geometry.....	2	Descriptive Geometry.....	2
9½-10½	Surveying.....	1	Surveying.....	1	Surveying.....	1	.....	.....	.....	.....
10½-11½	Trigonometry.....	5	Trigonometry.....	5	Trigonometry.....	5	Trigonometry.....	5	Trigonometry.....	5
11½-12½	.....	.....	.....	.....	.....	.....	German.....	5	German.....	5
2-5	Chem'l Laboratory.	3	.....	.....	Shop Practice.....	3	Chem'l Laboratory..	3	.....	.....
2-5	Field Practice and Drawing.....	2	Field Practice and Drawing.....	5	Field Practice and Drawing.....	2	Drawing.....	2	Drawing.....	2
Second Term 18 Weeks.										
8½-9½	General Chemistry..	3	General Chemistry..	3	General Chemistry..	3	General Chemistry..	3	General Chemistry..	3
9½-10½	Stereotomy.....	1	Stereotomy.....	1	Stereotomy.....	1	Stereotomy.....	1	Stereotomy.....	1
9½-10½	Surveying.....	2	Surveying.....	2	Surveying.....	2	.....	.....	.....	.....
10½-11¼	Analytic Geometry..	5	Analytic Geometry..	5	Analytic Geometry..	5	Analytic Geometry..	5	Analytic Geometry..	5
11½-12½	.....	.....	.....	.....	.....	.....	German.....	5	German.....	5
2-5	Chem'l Laboratory..	3	.....	.....	Shop Practice.....	3	Chem'l Laboratory..	3	.....	.....
2-5	Field Practice and Drawing.....	2	Field Practice and Drawing.....	5	Field Practice and Drawing.....	2	Drawing.....	2	Drawing.....	2

JUNIOR YEAR.

Hours for Lecture.	Course in Mining Engineering.	No. per week.	Course in Civil Engineering.	No. per week.	Course in Mechanical Engineering.	No. per week.	Course in Chemistry and Metallurgy.	No. per week.	Course in Mathematics and Physics.	No. per week.
8½-9½	Analytic Geometry { Calculus.....	3	Analytic Geometry { Calculus.....	3	Analytic Geometry { Calculus.....	3	.....	3	Analytic Geometry { Calculus.....	3
8½-9½	Mine Engineering.....	2	Physics.....	3	Physics.....	3	Physics.....	3	Physics.....	3
9½-10½	Physics.....	3	Mineralogy.....	3	Mineralogy.....	3	Mineralogy & Geol.....	3	Geology.....	3
10½-11½	Mineralogy.....	3	Geology.....	2	Geology.....	3	Geology.....	3	Geology.....	3
10½-11½	Geology.....	3	Mechanical Engineering.....	2	Mechanical Engineering.....	3	Ore Concentration.....	2	.....	2
11½-12½	Ore Concentration.....	2	(Railways & Highways).	2	(Kinematics & Machine Designs).	3	German.....	3	German.....	3
2-3	.....	3	Chemical Laboratory	1	Chemical Laboratory	1	Chemical Laboratory	3	German.....	3
3-5	Physical Laboratory	2	Physical Laboratory	2	Engineering Laboratory (Testing Materials)	2	Physical Laboratory	2	Physical Laboratory	2
2-5	.....	2	Field Practice and Drawing.....	2	Physical Laboratory	2	.....	2	French.....	3
8½-9½	Materials of Engineering { neering.....	3	Calculus.....	3	Calculus.....	3	.....	3	Calculus.....	3
8½-9½	Masonry Construction.....	2	Materials of Engineering { neering.....	2	Masonry Construction.....	2	.....	2	.....	2
9½-10½	Physics.....	3	Physics.....	3	Physics.....	3	Physics.....	3	Physics.....	3
10½-11½	Geology.....	3	Geology.....	3	Geology.....	3	Geology.....	3	Geology.....	3
11½-12½	Mineralogy.....	2	Mineralogy.....	2	Mineralogy.....	2	Mineralogy.....	2	.....	2
11½-12½	Metallurgy.....	2	.....	2	Mechanical Engineering (Machine Designs)	3	Metallurgy.....	2	.....	2
2-3	.....	3	Chemical Laboratory	1	Chemical Laboratory	1	German.....	3	German.....	3
3-5	Physical Laboratory	2	Physical Laboratory	2	Physical Laboratory	2	Physical Laboratory	2	Physical Laboratory	2
2-5	.....	2	Field Practice and Drawing.....	2	Engineering Laboratories (Testing Materials)	2	.....	2	French.....	3

First Term 18 Weeks.

Second Term 18 Weeks.

SENIOR YEAR

First Term 18 Weeks.		Second Term 18 Weeks.		No. per week.		Course in Chemical Engineering.		No. per week.		Course in Chemistry and Metallurgy.		No. per week.		Course in Mathematics and Physics.	
Hour for Lecture.		Hour for Lecture.		No. per week.		No. per week.		No. per week.		No. per week.		No. per week.		No. per week.	
8½-9½	Metallurgy.....	2	.....	.....	.....	.....	.....	.....	.....	Metallurgy.....	2	.....	.....	.....	.....
9½-10½	Hydraulics 12 W... {	5	.....	.....	.....	.....	.....	.....	.....	Metallurgical Laboratory (3 forenoons per wk)	3	.....	.....	Senior Mathematics.	5
10½-11½	Graphical Statics.. {	3	.....	.....	.....	.....	.....	.....	.....	Graphical Statics....	1	.....	.....	Analytic Mechanics.	3
11½-12½	Analytic Mechanics.. {	2	.....	.....	.....	.....	.....	.....	.....	Electricity and Magnetism.....	2	.....	.....	Electricity and Magnetism.....	2
11½-12½	Electricity and Magnetism.....	3	.....	.....	.....	.....	.....	.....	.....	Electricity and Magnetism.....	2	.....	.....	.....	.....
2-5	Chemical Laboratory	1	.....	.....	.....	.....	.....	.....	.....	Designing and Drawing.....	2	.....	.....	.....	.....
	Physical Laboratory	1	.....	.....	.....	.....	.....	.....	.....	Physical Laboratory	1	.....	.....	Physical Laboratory	2
	Drawing and Designing..	1	.....	.....	.....	.....	.....	.....	.....	Engineering Laboratory.....	2	.....	.....	French.....	3
8½-9½	Metallurgy.....	2	.....	.....	.....	.....	.....	.....	.....	Metallurgy.....	2	.....	.....	.....	.....
8½-9½	Prime Movers and Power Transmis'n.	3	.....	.....	.....	.....	.....	.....	.....	Metallurgical Laboratory (3 forenoons per wk)	3	.....	.....	Senior Mathematics.	5
9½-10½	Contract Law and Specifications....	2	.....	.....	.....	.....	.....	.....	.....	Contract Law and Specifications.....	2	.....	.....	.....	.....
10½-11½	Bridge Engineering.	3	.....	.....	.....	.....	.....	.....	.....	Applied Mechanics..	3	.....	.....	Electricity and Magnetism.....	2
11½-12½	Sanitary Engineering	3	.....	.....	.....	.....	.....	.....	.....	Electricity and Magnetism.....	2	.....	.....	.....	.....
11½-12½	Applied Mechanics..	2	.....	.....	.....	.....	.....	.....	.....	Designing and Drawing.....	2	.....	.....	Physical Laboratory	2
2-5	Chemical Laboratory	1	.....	.....	.....	.....	.....	.....	.....	Physical Laboratory	1	.....	.....	.....	.....
	Physical Laboratory	1	.....	.....	.....	.....	.....	.....	.....	Engineering Laboratory.....	2	.....	.....	French.....	3
	Drawing.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

NOTE.—Two hours of Laboratory work are considered equivalent to one hour in lecture or recitation.

Department of Engineering.

PROF. HARRIS.

T. G. POATS, *Assistant.*

The term "Civil Engineering" in its original sense includes all branches of engineering not military; but the term thus used is too comprehensive to define properly the work of a specialist of to-day. Hence, the necessity of further subdivision of Civil Engineering, properly so-called, into several branches, principal among which are Mining Engineering, Mechanical Engineering and Civil Engineering in a more restricted sense, in which it applies to the art of "designing, laying out, and constructing fixed structures, such as railways, canals, bridges, docks, embankments, dams, tunnels," etc. It is in this restricted but popular sense that the term "Civil Engineering" is used in distinction from Mining and Mechanical Engineering.

All branches of engineering are necessarily based on the sciences of Mathematics, Physics and Chemistry. The distinctive title is not usually bestowed until the knowledge of these sciences is applied to some specific useful purpose. It will be seen, then, that the college work of the student must be much the same whatever special line of application he may have chosen.

After the Freshman year the afternoons are given up for practice and experiment in field work and the laboratories, by which the students are made familiar with, and masters of such problems as occur in professional work. The field-work is given during the pleasant months of October, November, April and May. The greater part of the drawing is done during the winter months. In field practice the Sophomore Classmen enter the Corps as rodmen, and must do duty in that capacity before being advanced. The Junior Classmen enter as instrument men, and are taught easy and accurate manipulation of

the instruments. The Senior Classmen are placed in charge of the field practice, and are to direct and check the work, with the assistance of the Instructor.

The Engineering Department is equipped with field instruments of the best make, sufficient to operate two full corps at once. Other instruments and apparatus will be added to meet all requirements.

The introduction of Shop Practice was the distinctive feature of the Session of 1892-3. The appropriation by the Thirty-Seventh General Assembly of \$25,000 for a building and equipments, will enable the School to offer a thorough course in Practical Mechanics. The Shop Practice begins in the Freshman year, and is there common to all Engineering Students. It consists of a graduated series of exercises in Wood Work, including joining, carving and turning. Each student is provided with a complete set of carpenter's and carving tools.

The Laboratory work mentioned in this department is carried out, wherever the necessary apparatus is to be had, either in the Chemical, Physical or Mechanical Laboratories.

SOPHOMORE.

Descriptive Geometry.—Theory of parallel and of central projections as applied to the art of draughting, with constant exercises in determining orthogonal and oblique projections of familiar objects.

Field Instruments.—The field instruments of the engineer are dissected and studied in detail, their theory, construction and adjustments receiving careful attention. Their uses and capabilities are thoroughly discussed and applied in field practice.

Stereotomy.—The application of Descriptive Geometry to the art of stone-cutting—obtaining the projections, templates and directing instruments for the individual stones in the various forms of structures and the construction of models of the same.

Engineering Geodesy.—General and particular methods of traversing, triangulating, direct and indirect leveling; land, city, topographical and hydrographical surveying; United States system of subdivision of land.

Drawing.—Much of the first year's work in the Engineering Department is at the drawing-board. All work in Descriptive Geometry and in Stereotomy belong to the Department of Drawing. The student is first taught the use of the drawing instruments. Then, beginning with the simplest problems in points, lines and planes, he advances step by step, to the graphical solution of the most complicated problems with which he is likely to meet in practice. Such projections as he is caused to make in his work in Descriptive Geometry he is required to shade properly either in pencil, free hand pen work, or with the ruling pen; others will be tinted in water colors and shaded with India ink, thus acquiring easy and effectual use of pencil, pen and brush.

Field Practice.—The student is first taught to adjust the instruments properly and to test their accuracy. Problems are then assigned in traversing and parting off land, in direct and indirect leveling, and in triangulations, all of which must be carried out in the field. A topographical map must be produced by each student from stadia measures taken in the field.

Shop Practice.—The exercises are in bench and lath work in iron, brass and steel; forge work in tool making and tempering; and pattern making and moulding.

JUNIOR.

Mine Surveys.

Exploitation of Mines.—Theory of deposits in beds, lodes and pockets, prospecting, exploration and development by shafts, inclines and tunnels; underground transportation, drainage, ventilation, lighting.

Explosives—Blasting—Tunneling.

Materials of Engineering.—The principal timbers, metals, stones, clays, cements, etc. used in Engineering Construction are studied; the investigation including sources of supply, demand, preparation, tests and modes of preservation.

Masonry Construction.—Foundations, strength and stability of stone and of brick masonry, concretes, cements and mortars, specifications.

Railroad Engineering.—Surveys, construction and maintenance.

Highway Engineering.—Surveys, construction and maintenance: street paving.

Kinematics and the Principles of Mechanisms.—The communication of motion by belts, cables, gear-wheels, cams, screws and links, and the design of trains of mechanisms.

Machine Design.

Laboratory Work.—The materials of engineering are tested for strength, elasticity and endurance.

Field Practice.—The student is exercised in railway surveying and in staking out earthwork and masonry. A map, profile and estimate of cost of a section of railway must be produced from notes taken in the field

Drawing.—In the Junior year the work assigned in drawing is adapted to the profession chosen by the student. The students in Civil and in Mining Engineering will select some complete engineering structure and present it in simple plan and elevation—one in axonometric, another in perspective—all neatly shaded, tinted and lettered. A badly finished drawing will not be accepted, and must be replaced. All field surveys must be plotted neatly, and one topographical drawing made from notes taken in the field by the student will be required of each. The student in Mechanical Engineering will be continuously exercised in mechanical and machine drawing.

SENIOR.

Hydraulics.—Collection and measurement of water, conveyance through pipes and canals; design of dams and pipe lines.

Sewerage, Water Supply of Cities and Irrigation.

Graphical Statics.

Bridge Engineering.—Determination of loads, strains and dimensions for bridges, roofs and other framed structures.

Prime Movers.—Hydraulic motors, steam engines and boilers, horse-power appliances.

Transmission of Power.—Cable, compressed air, electricity.

Mining Machinery.—Pumps, ventilators, hoists, drills.

Law of Contracts.

Field Practice.—The senior classmen direct and check the work of the Sophomore and Junior class in the field. All being under the control of an instructor.

Drawing.—A variety of exercises in graphical statics must be solved, and working drawings of such subjects as relate to the special branch of Engineering chosen by the student. The Thesis must be accompanied by drawings fully illustrating it.

Laboratory Work.—Experiments with the indicator, dynamometer and calorimeter. Tests of the efficiency of machines.

Department of Chemistry and Metallurgy.

PROF. W. H. SEAMON.

D. C. JACKLING, *Assistant.*

The courses in this department have been arranged solely for the benefit of those who wish to prepare themselves for positions as Assayers, Chemists, Metallurgists and Engineers.

Instruction in the following courses is regularly given each session.

- I. ELEMENTARY CHEMISTRY.
- II. GENERAL CHEMISTRY.
- III. ORE CONCENTRATION.
- IV. METALLURGY.
- V. BLOWPIPE ANALYSIS.
- VI. QUALITATIVE ANALYSIS.
- VII. ASSAYING AND TECHNICAL ANALYSIS.
- VIII. MINERAL AND GAS ANALYSIS.

I. *Elementary Chemistry*.—This course is intended to acquaint the student with the elementary principles of chemical science, without going into the minor details. Norton's Elements of Chemistry is used and experiments to illustrate the course are given before the class.

II. *General Chemistry*.—The instruction in this subject is communicated by lectures and recitations based upon Cook's Chemical Philosophy. Much time is devoted to regular exercises in Stoichiometry.

III. *Ore Concentration*.—The instruction in this subject is exhaustively treated by lectures and covers the following ground:

1. Physical properties upon which ore-dressing is based
2. Theory of jigging and treatment of slimes. 3. Hand-dressing, cobbing, etc. 4. Crushing machinery. 5. Sizing machinery. 6. Assorting machinery, Jigs, Vanners, Revolving Tables, Buddles, Settlers, etc. 7. Types of Ore-dressing Plants.

Drawings and Photographs are employed to illustrate the work.

IV. *Metallurgy*.—During the second term of the Junior year, Fuels; Refractory Materials; Furnaces and the general principles of Metallurgical operations are studied; followed in the Senior year by a thorough consideration of the Metallurgy of Iron; Steel; Lead; Copper; Zinc; Silver and Gold. Philip's Elements of Metallurgy and the Professor's notes on American practice cover the course.

Works of Reference.—Crook's and Rohrig's; Eggleston and Percy's Works and the Transactions of the American Institute of Mine Engineers.

V. *Blowpipe Analysis*.—Fifteen hours each week, during the first term, of the sophomore year, is devoted to practical exercises with the blowpipe. The student is required to attain skill sufficient to readily detect the common metals, bases and acids in all common forms of occurrence. Erni's Blowpipe Analysis is used as a guide.

VI. *Qualitative Analysis*.—Fifteen hours each week of the second term is devoted to practical exercises in Qualitative Analysis. The difficulties of these exercises are gradually increased and continued until the student is perfectly familiar with the subject.

VII. *Assaying and Technical Analysis*.—After the completion of the exercises in Qualitative Analysis, the student is required to make complete analyses of Barium Chloride; Di-Sodic Phosphate; Strontium Nitrate and Nickel Ammonium Sulphate. This work is intended for proper training in the chemical manipulation necessary for accurate Quantitative work. The quick methods, fire, volumetric and gravimetric,

employed by assayers and chemists in metallurgical plants are then taught and applied by the students to the analysis of ores of Copper ; Zinc ; Lead ; Iron ; Antimony ; Tin and Manganese ; Steel ; Cast Iron ; Mattes ; Slags ; Fluxes and Furnace materials are also treated of and required to be analyzed by the students.

A good worker can complete the course in one session, working about twenty-four hours per week.

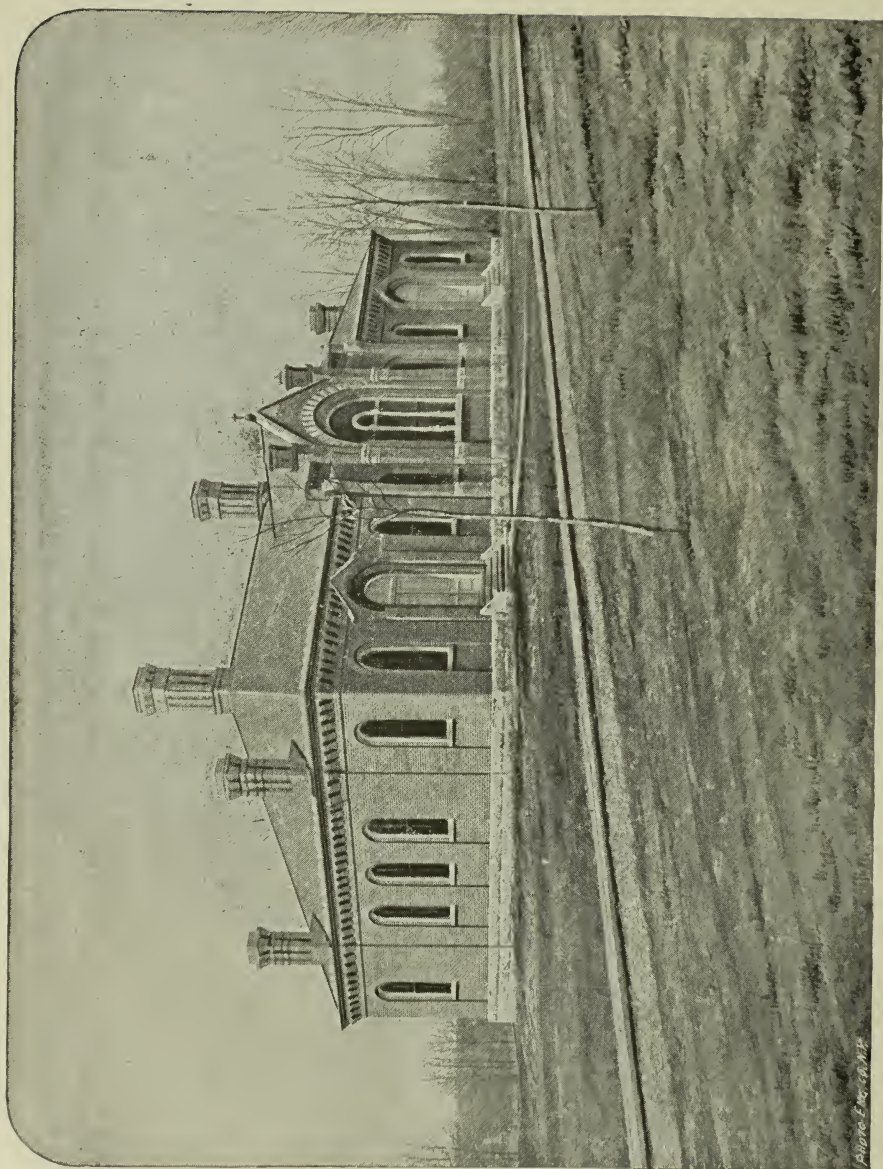
VIII. *Mineral and Gas Analysis*—The work in this course requires thirty hours per week, and is intended to familiarize the student with the most accurate methods of analysis, neglecting the consideration of time. Different methods of Analysis are investigated and rare minerals examined, for the purpose of encouraging a spirit of investigation in the student.

The Professor's notes in conjunction with Fresenius' Qualitative and Quantitative Analysis are used as texts.

Special students may with the approval of the faculty pursue courses of their own selection, except in the line of Organic Chemistry. Young men who have neither the time nor means to spare to take the full course may accomplish much in the way of chemical analysis and assaying by devoting their entire time to it during a single year.

A certificate as an assayer is given to one who graduates in courses II, V, VI and VII and Mineralogy. Some men by hard work can complete this course in one session.

All students are required to furnish their own blowpipes, platinum crucibles, silver and gold solutions, and pay for all materials consumed and for all school apparatus damaged or destroyed.



LABORATORY.

Mineralogy and Geology.

PROF. W. H. SEAMON.

Crystallography, Physical and Systematic Mineralogy are taught by lectures and recitations twice each week during the Junior year. Models, drawings and a large collection of specimens are handled by the class. In connection with this work a series of exercises in Determinative Mineralogy are given in conjunction with the work in the Chemical Laboratory.

The course is concluded by fifteen lectures on Lithology.

Dana's Text Book of Mineralogy is recommended as a Text.

Geology, including Dynamical, Physical, Structural, Historical and Economic, is taught by lectures and recitations, based upon Dana's Manual of Geology.

Economic Geology, including a detailed course on Ore Deposits, is taught entirely by lectures. The class meets three times each week throughout the Junior year.

Excursions are made for instruction in practical geology.

THE CHEMICAL LABORATORY.

The Chemical Laboratory has been in use six years, and has been found satisfactory. It was planned and built solely with reference to the work in the school, and the entire building is used by the Chemical Department.

In this building there are the following departments. The quantitative laboratory, the qualitative laboratory, professor's laboratory, lecture room, assay laboratory and weighing room, a quantitative and qualitative evaporating room, preparation room, a supply room and two basement rooms, furnishing accommodations for seventy-five students.

In the construction of this Laboratory no pains were spared to make the Assay Laboratory complete in every respect. It is located on the first floor, and not in the basement. The reduction furnace, as well as the muffle furnaces, are of the newest and best. Two large muffle furnaces, two smaller ones, one gas furnace, an ore crusher, pulverizing plate, ore and assay balances, with other facilities, are provided for the use of students.

Facilities for securing heat, light and ventilation are excellent; ample provision is also made for carrying off foul and dangerous gases. All parts of the building are thoroughly and judiciously equipped; nothing has been left undone to make this laboratory one of the most complete in the country. Gas and water are supplied to each table.

The laboratory contains, in addition to a large assortment of the apparatus regularly and ordinarily met with in well equipped institutions, three of Becker's Analytical Balances, Contact and Reflecting Goniometers, and other valuable pieces of apparatus for work and research.

The Chemical Laboratory is open to students for work daily from 8 A. M. to 5 P. M.

Department of Mathematics.

PROF. RICHARDS.

The exceeding importance of Mathematics as the basis of a scientific education justifies the emphasis laid upon it in the school. At the same time that the facts are taught, the utility of mathematical study as a mental discipline is duly recognized, and an effort is made to promote habits of exact, logical reasoning, and to stimulate originality and independence of thought.

In the Engineering courses the ultimate intention of the student is kept prominently in mind, and such points as have an especial bearing upon his technical work are emphasized as

occasion may suggest. The tendency, however, too frequently observable in technical schools, to cramp the mathematical instruction within the limits of a meagre preparation for professional work, is avoided, and the treatment of each subject is, in general, designed to be as broad and full as may be in the allotted time.

At each meeting the class is examined on matter previously assigned, and, when expedient, explanations of the text and supplementary lectures and notes are given. The student is constantly exercised in work at the blackboard, reproducing demonstrations and applying demonstrated principles to the solution of special examples.

FRESHMAN CLASS.

Algebra.—The course in Algebra will include a rapid review of the elementary processes, a wider discussion of problems leading to equations, with the interpretation of their results, Theory of Exponents, Surds, Imaginaries, the Progressions, Permutations and Combinations, Binomial Theorem, Series, Logarithms, Theory of Numbers, Determinants, with an introduction to the Theory of Equations.

Text Book.—Wells' University Algebra, with notes.

Geometry.—At the same time the class takes a thorough course in the old (Euclidian) Geometry, with numerous original exercises. Text book—Wells' Plane and Solid Geometry. Required in all the courses.

SOPHOMORE CLASS.

The Sophomore Class studies Trigonometry, Plane and Spherical, throughout the first half of the year. The class is thoroughly drilled in the Fundamental Definitions and Formulæ. The construction and use of Logarithmic tables are taught, and numerous examples in the solution of triangles, involving the use of Logarithms, are given. Occasionally actual heights and distances are required to be calculated by Trigonometric methods.

The second half of the year is taken up with the study of the Conic Sections and a few of the Higher Plane Curves.

TEXT BOOKS.—Wells' Plane and Spherical Trigonometry. Wentworth's Analytic Geometry.

For Reference.—Todhunter's Plane and Spherical Trigonometry; Puckle's Conic Sections, Salmon's Conic Sections, Searle's or Henck's Field Book.

This class is uniformly required in all the courses.

JUNIOR CLASS.

The class begins with Analytic Geometry of Three Dimensions, studying chiefly surfaces of the second degree. The remainder of the year is devoted to the Infinitesimal Calculus. The student is guarded against the error of supposing that the Calculus means some certain body of knowledge, small or large, and is taught to view it in its true light as a method of analysis, the applications of which are infinite. The logical foundation of the subject is firmly laid in the Doctrine of Limits, and the class is introduced to the applications—both geometrical and mechanical—of its principles, which are most important, both on account of the intrinsic utility of their results, and, as well, as illustrating the efficiency of the instrument which the student is learning to use.

TEXT BOOKS.—Venable's Notes on Solid Geometry, Taylor's Elements of the Calculus (with Notes and Lectures).

For Reference.—Salmon's, Todhunter's and Williamson's mathematical works.

The above is required in Courses I, II, III, V.

For students of Mining Engineering, to compensate for larger requirements in Chemistry and Metallurgy, a briefer treatment of the above subjects, extending through one term, will be given. This will include such a short discussion of Analytic Geometry of Three Dimensions as is found in Wentworth's Analytic Geometry, and in Calculus as much grasp of essentials (from above-mentioned text and notes) as the limited time will permit.

SENIOR CLASS.

Applicants for Engineering degrees will take a course in Analytic Mechanics, extending through one term. Text Book, Bowser's Analytic Mechanics.

Students pursuing the special course in Mathematics and Physics (V), and such others as may wish to extend their mathematical study beyond the usual undergraduate range, do a full year's reading, the nature of which will be susceptible of a certain amount of variation from year to year as the judgment of the Professor and the needs of the applicants may suggest.

The first half of the next year will be devoted to a wider study of the Conic Sections, with the use of both Algebraic and Projective methods. Text Books, Salmon's Conic Sections, Cremona's Projective Geometry.

In the second half year the class will read some of the more advanced portions of Williamson's Differential and Integral Calculus, and will study one of the following subjects: Theory of Equations (Burnside & Panton), Determinants (Muir), Differential Equations (Forsyth), Quaternions (Kelland & Tait, and Tait).

In all the classes, as each subject is taken up its origin and development are studied too, and at certain periods, because more formal lectures on the History of Mathematics are given.

A collection of the chief works on Mathematics, in English, French and German, which is contained in the Library, affords the student an opportunity of extending his research at will.

Department of Physics.

PROF. McRAE.

The Physical Laboratory occupies three rooms in the main building and is supplied with standard measuring instruments. A workshop connected with the Laboratory is supplied with the necessary tools and the student is encouraged in designing and making with his own hands any special appa-

ratus he may require. Recitations, experimental illustrations and laboratory work go hand in hand throughout the course, making the instruction thorough and complete. The instruction in detail is as follows:

FRESHMAN CLASS.

Elementary Physics.—This class meets three times a week during the first term. Elements of Physics by Carhart and Chute is used as a text book.

Physical Laboratory.—Two hours a week during the first term. Simple measurements, with exercises from Worthington's Physical Laboratory Practice. The laboratory work is required in the Technical courses and is optional in the Academic course.

Elementary Mechanics.—Twice a week throughout the year.

JUNIOR CLASS.

Physics.—This class meets three times a week throughout the year. The subjects studied the first term are:

Meteorology, with special reference to rainfall and water supply; Heat, general principles, thermometry and calorimetry; Optics, optical instruments and photometry.

The subjects studied during the second term are Electricity and Magnetism.

Students in Mechanical Engineering are given a special course in Electricity two hours a week throughout the year.

Physical Laboratory.—Six hours a week throughout the year is devoted to work in the Physical Laboratory. The experiments are measurements of length, mass and time, thermometry, calorimetry, coefficients of expansion, focal length and curvature of lenses, index of refraction, wave length, photometry, electromotive force, current and resistance of electric circuits, and magneto-motive force, flux and reluctance of magnetic circuits.

SENIOR CLASS.

Dynamo-Electric Machinery.—This class meets twice a week throughout the year and studies dynamo electric machinery and the transmission of energy by electricity.

Physical Laboratory.—Three hours a week throughout the year are spent in the Electrical Laboratory, experimenting in Characteristic curves and efficiency tests of dynamos and motors, measurements of current, electromotive force, etc., and the calibration of commercial measuring instruments, electric light and telephone wiring, photometry, electric lighting and power transmission, and the design and construction of electrical machinery. Students in metallurgy are given their laboratory work in electro-metallurgy, and those in mining engineering study the use of electricity in mining operations.

Applied Mechanics.—During the second term of the senior year the class meets three times a week for instruction in applied mechanics.

Practical Astronomy.—One lecture a week is given during the second term to students in Civil Engineering on the practical methods of determining time, latitude and longitude.

SPECIAL COURSE IN ELECTRICITY.

For the benefit of those students who are unable to remain in college the full four years, but who wish to acquire a foundation for practical electrical engineering, a two-years' course has been arranged. This includes the regular course in Mathematics through trigonometry, all the Physics and Electricity and Physical Laboratory; a two-years' course in Drawing, Shop Practice and Machine design, and special laboratory work during the second year. For the satisfactory completion of this course a certificate of proficiency will be given.

Modern Languages.

A reading knowledge of French and German is a highly desirable part of a scientific education. The press of more immediately essential subjects has kept these languages from being included among the requirements of the Engineering degrees, though every student who can spare the time is advised to acquire at least one of them. In the course in Chemistry German is required, while both French and German are necessary for the degree in "Mathematics and Physics."

The instruction in each language is designed to present the grammatical structure and the pronunciation of the tongue, to give some acquaintance with the master-pieces of its literature, and to confer such facility in translation as will enable the student to read with ease the language in both its literary and its scientific uses.

GERMAN.

MR. WILKINS.

First year.—"Dreyspring's Cumulative Method," containing Conversation, Grammar, and Reading-exercises sufficient to occupy the whole time during the first year.

Second year.—Schiller's "Wilhelm Tell;" Lessing's "Nathan der Weise;" Goethe's "Reinecke Fuchs;" and selections from various other German authors.

The Scientific Studies.—Hodges' "Scientific German." Chemical students also read some work on Chemistry and Metallurgy; mathematical students read some good mathematical work.

FRENCH.

PROF. RICHARDS.

First year.—Otto's Grammar and Reader, "Choix de Contes" (Daudet), "Un Philosophe sous les Toits" (Souvestre), "L'Avare" (Moliere).

Second year.—Grammar (continued), original exercises, Racine's "Phedre," "Le Roman d'un Jeune Homme Pauvre" (Feuillet), "L'Abbe Constantin" (Halery), Marie's "Histoire des Sciences" or some scientific work in French.

Parallel reading, outside of that done in class, will be assigned and will constitute part of the work on which the student is examined.

Academic Course.

The following Academic Course of study was established in pursuance of an act of the Legislature of Missouri, in 1885. It is designed to make the course equal in every respect to those offered at the best academies. As now arranged, it will commend itself especially to young men who wish to fit themselves for successful business or professional life, and to teachers who wish to prepare for higher work in their calling. The completion of the first year of this course admits the student in any of the professional courses without examination. A Diploma of Graduation will be granted to students who complete the course.

ACADEMIC COURSE.

FIRST YEAR.

FIRST TERM.			SECOND TERM		
Hours of Recitation.	Study.	Times per wk.	Hours of Recitation.	Study.	Times per wk.
8:30 to 9:30	Higher Arithmetic.....	5	8:30 to 9:30	Higher Arithmetic.....	5
9:30 to 10:30	Elementary Algebra....	5	9:30 to 10:30	Elementary Algebra. ..	5
10:30 to 11:30	American History... ..	5	10:30 to 11:30	Physiology and Hygiene	3
11:30 to 12:30	English Grammar.	5	11:30 to 12:30	Composition and Rhetoric.....	5

SECOND YEAR.

9:30 to 10:30	General History.....	5	9:30 to 10:30	General History.....	5
11:30 to 12:30	German	5	10:30 to 11:30	Civil Government.....	5
2:00 to 3:00	Geometry (Plane).....	4	11:30 to 12:30	German	5
3:00 to 4:00	Zoology	5	2:00 to 3:00	Geometry (Solid).....	4

THIRD YEAR.

8:30 to 9:30	English and American Literature.....	3	8:30 to 9:30	English and American Literature... ..	3
9:30 to 10:30	Higher Algebra.....	5	9:30 to 10:30	Higher Algebra.	5
2:00 to 3:00	German	3	2:00 to 3:00	German.	3
3:00 to 4:00	Elementary Physics... ..	3	3:00 to 4:00	Elementary Chemistry..	3

FOURTH YEAR.

8:30 to 9:30	Psychology.....	2	8:30 to 9:30	Logic.....	2
9:30 to 10:30	Physical Geography....	2	9:30 to 10:30	Descriptive Astronomy.	2
10:30 to 11:30	Trigonometry	5	10:30 to 11:30	Book-keeping (optional)	2
2:00 to 3:00	English History.....	5	2:00 to 3:00	Political Economy.....	5
			3:00 to 4:00	Botany	5

MATHEMATICS.—A thorough knowledge of elementary Algebra and Geometry is absolutely essential to any successful prosecution of the higher branches of Mathematics, and this course is framed to give those insufficiently prepared in these subjects an opportunity to obtain the requisite acquaintance

with them. The studies of the first year are Arithmetic and Elementary Algebra. To Arithmetic one year is devoted; to Algebra, two. Students who can produce satisfactory evidence of a sufficient knowledge of Arithmetic will not be required to pursue that study. The object of the course is to give the student a comprehension of the principles involved in the elementary branches and a thorough acquaintance with their immediate application. The solution of original problems, so valuable both as an exercise and a test of acquirement, is made a prominent feature of the course.

In Arithmetic the vital principle and not the mere mechanical rule is what is sought to be inculcated, and the working of examples is a means, not an end. Incidentally, short methods of multiplication and division are introduced and insisted upon. In Algebra, the course begins with the fundamental operations and extends through Quadratic Equations and the Progressions. The class in Geometry completes the usual course in old Geometry, Plane and Solid.

Text Books.—Heath's New Arithmetic. Algebra. First year—Well's Academic Algebra. Second year—Well's University Algebra, Well's Plane and Solid Geometry, Well's Plane and Spherical Trigonometry.

PHYSIOLOGY.—It is aimed to make the instruction in this branch as practical as possible, and to lead the student to obey the injunction, "Know thyself." Hints on hygiene are given, also rules in case of emergency.

Text Book.—Steele's Hygienic Physiology.

ENGLISH GRAMMAR.—A familiarity with forms and with principles of construction is insisted upon. Written exercises are required daily, from the belief that painstaking practice under proper supervision is the best, if not the only, means of acquiring facility in the use of good English.

Text Book.—Longman's Grammar.

COMPOSITION AND RHETORIC.—It will be seen that this subject follows immediately, as it naturally should, upon that of Grammar. The student is required to practice letter writing

at the very beginning of the work. From this style of composition to others, the steps are taken with ease. Instruction is given with view to practical results; it is designed not only to impart a knowledge of principles, but also to develop a facility in the application of them.

Text Book.—Hill's Elements of Rhetoric and Composition.

AMERICAN HISTORY.—An attempt is made to impart a knowledge of the causes and effects of the important events of history rather than to fill the mind of the student with an undigested mass of detail. Especial attention is given to the history of our country under the Constitution. The drawing of historic maps, recitations from topics assigned, and frequent written reviews, are important features of the work.

Text Book.—Barnes' Brief History of the United States.

GENERAL HISTORY.—It is designed to give the student as thorough knowledge as possible of Ancient, Mediæval and Modern History. For this reason it is thought best to continue this study through the entire year. Students will be enabled to lay a good foundation for future historical and literary work.

Text Book.—Meyer's General History.

CIVIL GOVERNMENT.—The text book now in use (Young's Class Book) gives an analysis of the Constitution of the United States, presents a comparative view of the different State Governments, treats of County and Township organizations, and affords an acquaintance with such principles of law as are involved in ordinary business transactions. Special attention will be given the Government of the State of Missouri.

GERMAN.—The course extends through two years, and consists of exercises in translation and conversation, and of a study of the gems of German literature. An effort is made, first of all, to give the student a thoroughly practical knowledge of the language. In addition to this, technical students may acquire such facility in translation as will enable them to read German scientific works in the original. The excellent

mental discipline that may be derived from the study of a foreign language, and the great aid that such study may afford to the understanding of one's own language, is not overlooked.

ENGLISH AND AMERICAN LITERATURE.—It will be seen that this subject extends through the entire year. The aim is to lead the student to form a correct estimate of the literary value of English and American productions, and also to direct his attention to the peculiar social and political condition of which the literature is an expression. Time is given to a study of the masterpieces from Chaucer's time to the present, and to a perusal of standard authorities on the literature of the language. The last half of the year is devoted to a very careful study of American Literature. The library is well supplied with works of reference.

Text Books.—Shaw's History of English and American Literature. American Literature by Hawthorne and Lemmon.

PHYSICS.—In the course the object constantly held in view is to present simply and plainly the fundamental truths of Natural Philosophy. The subjects of properties of matter, sound, light, heat, and electricity are introduced upon a scientific basis and are illustrated throughout the course by experiments. The department is supplied with apparatus of all kinds necessary for this purpose.

Text Book.—Elements of Physics by Carhart and Chute.

CHEMISTRY.—In this course instruction is given by both inductive and deductive methods. Students are supplied with work-tables, apparatus and chemicals, and under the supervision of the instructor they perform all of the experiments given in Norton's Elements of Chemistry. One meeting of each week is given up to careful and searching questioning and drill in the recitation room. The class meets three times each week throughout the second term.

PSYCHOLOGY.—The aim in this study is to place before the student, in as simple and compact form as possible, a few of the leading facts connected with the human mind—its powers,

its capabilities, its growth, and some of the ways by which its powers may be strengthened and cultivated.

Text Book.—Hewett's Elements of Psychology.

LOGIC.—This study is intended to supplement that of Psychology. In the latter we have the analysis of the intellectual powers, in the former an investigation of the laws of correct reasoning.

Text Book.—Gilmore's Outlines of Logic.

PHYSICAL GEOGRAPHY.—In this branch attention is directed to the causes of natural phenomena. Meteorology and the Weather Bureau receive special attention.

Text Book.—Guyot's Physical Geography.

BOOK-KEEPING.—This study is not required, but will be taught upon the application of at least five students for instruction therein. The course comprises principally Double Entry. Various kinds of business are represented, and all the modern conveniences and auxiliaries are explained and used. The student is required to finish at least six different sets of books. Those who complete these before the end of the term will be furnished with abundant material for further practice.

ASTRONOMY.—The class in Descriptive Astronomy meets three times a week during the second term and pursues the subject as given in Newcomb and Holden's Astronomy.

BOTANY.—The course comprises the elements and principles of descriptive and systematic Botany, together with occasional lectures on the economic uses of various plants. The student is required to begin the analysis of plants as soon as they begin to bloom in the spring, and to continue analyzing till the end of the term. Frequent botanical excursions by the class are insisted on for the purpose of familiarizing the student with the haunts and habits of all the common plants of the vicinity.

Text Book.—Gray's School and Field Book.

POLITICAL ECONOMY.—Practical exercises constitute an important feature of the text book used. No attempt is made

to inculcate any particular economic doctrine, but it is sought to give the student such an understanding of the principles of the science that he may apply them intelligently to the solution of such questions as may come under his consideration.

Text Book.—Elements of political Economy, Chapin's Wayland.

ENGLISH HISTORY.—An effort will be made to present the subject in a manner that shall illustrate the great law of national growth, in the light thrown upon it by the foremost English historians. The Library contains the works of many leading authorities on the subject, and students are required to make constant use of them.

Text Book.—Montgomery's "The Leading Facts of English History."



General Information.

LOCATION.

The Missouri School of Mines is located in Rolla, the county seat of Phelps County. Rolla is a city of 2,000 inhabitants, on the St. Louis & San Francisco Railroad, about midway between St. Louis and Springfield, with an elevation of about 1,100 feet above sea-level. It is a pre-eminently healthful location and has a salubrious climate.

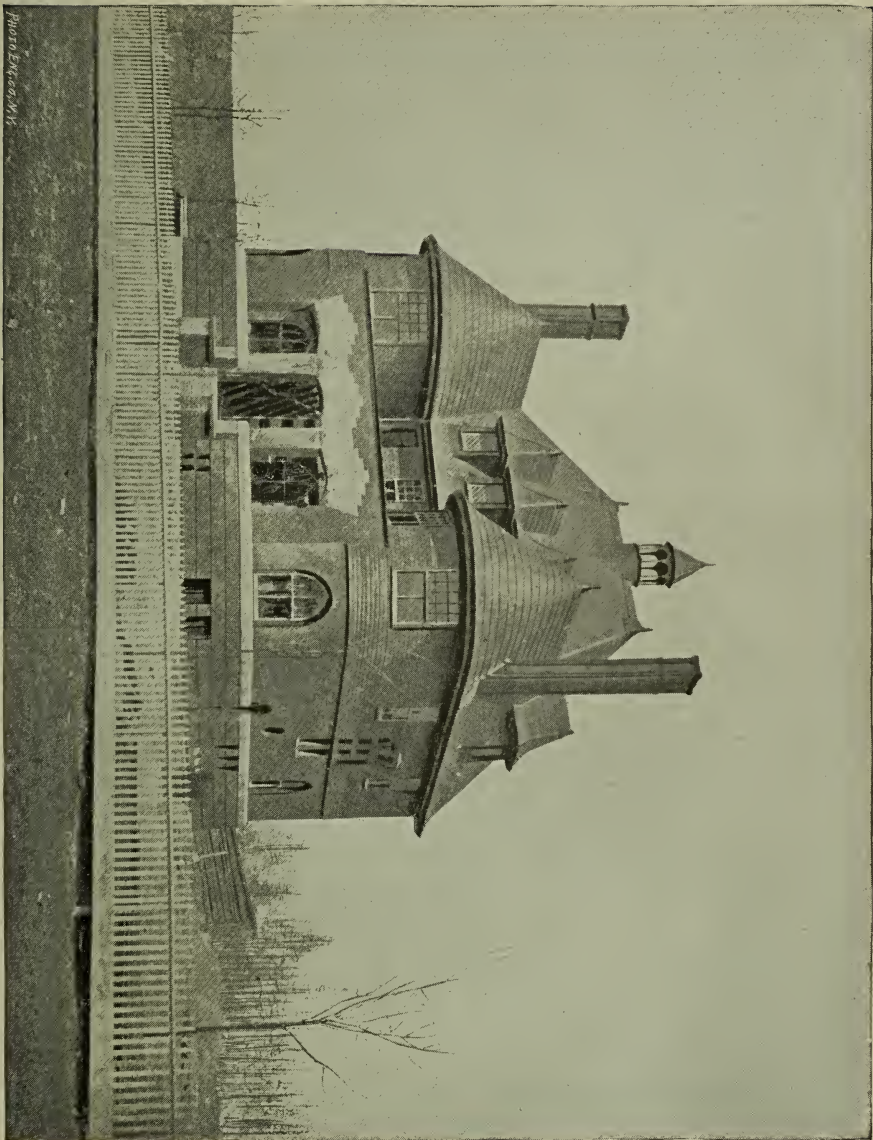
BUILDINGS AND EQUIPMENTS.

The buildings of the School of Mines are situated in the most elevated part of the city of Rolla. They are substantial brick structures, well ventilated and lighted, and heated by the best furnaces manufactured. The main building has recently been painted and kalsomined throughout, and the Laboratory, one of the most complete in the country, has been in use but five years.

The school has this year (1893) \$25,000 for building and equipments. The expenditures will be made under the directions of the Executive Committee. Provision will be made for a Geological Museum, and the Engineering Metallurgical Laboratories will be perfected. Details are not yet arranged, but the Board thinks the work can be finished by February, 1894.

The students' Club House, or Dormitory, built in 1890, contains commodious and comfortable rooms for thirty young men. Two students occupy one room. The dining hall and culinary department can accommodate sixty. This year the students pay \$12 a month for board in the club house. Whenever they shall deem it desirable the students will be allowed to form themselves into a club and employ their own

Photo Engraving



MESS-CLUB HOUSE.

caterer. In this manner it is believed that they will be able to board themselves at comparatively low cost.

Students wishing to engage rooms in the club building for next year should do so before September 1, as the supply of rooms may be exhausted. To engage a room a deposit of \$5 is required as an earnest of good faith on the part of the student. This money shall be refunded at the opening of the school whether the student shall take the room or not.

EXPENSES.

A Matriculation Fee of \$10 payable on entrance, and a *Library Fee* of \$2 a term, payable on the first day of each term are required of every student. Students who enter the first of the year pay \$12 the first term and \$2 the second term; students who enter the second term pay \$12.

The cost of books and stationery (too variable to be introduced into a general estimate) may be assumed to average \$10 during the session.

All laboratory students furnish their own blowpipes, platinum, silver and gold solutions, crucibles and apparatus, and pay for gas and fuel consumed and for apparatus damaged or destroyed. A deposit of \$5 per term, covering the value of the apparatus and chemicals issued, is required to be placed in the hands of the Treasurer by each laboratory student. This deposit, less the value of material consumed, is returned at the close of the year.

Board, including fuel, lights, washing, etc., can be obtained for \$12 to \$15 per month.

The necessary expenses for the school year are as follows:

	Moderate.	Ample.
Matriculation fee.....	\$ 10 00	\$ 10 00
Library fee.....	4 00	4 00
Books, stationery and chemicals	15 00	25 00
Board, fuel, lights, washing, etc.....	96 00	135 00
Total ...	\$125 00	\$174 00

RESIDENT GRADUATES.

It is hereby resolved by the Board of Curators, That hereafter all regular graduates of any department of the University, and every regular graduate of the Normal Schools established by law within this State, and the graduates of all other regularly chartered Literary and Scientific Colleges in this State with regular classes established therein, and that are authorized by law to confer degrees and to grant diplomas to their students, shall be entitled to enter all the departments of the State University, including the School of Mines at Rolla, as Post-Graduates, free of the payment of tuition fees, and to receive instruction in the same manner as other students in the Practical, Literary and Scientific Departments or classes (and all students taught in the University), and which they may choose to enter. *Provided*, however, that neither Law nor Medical students are included in this resolution. And, also, that they may have full access to the Library of the University, with all other students, on such terms and under such rules as may be prescribed by the Executive Committee.

The University publishes a list of schools whose certificate will admit the bearer to the Freshman class without examination. By an order of the Board of Curators the student who attains the highest rank in the graduating class of any school so approved, will be permitted to enter the Academic department, the Agricultural and Mechanical College or the school of Mines and Metallurgy without the payment of the ordinary matriculation fees.

LIBRARY.

The Library contains 3,000 volumes. Extensive works upon Engineering, Mathematics, Chemistry, Physics, Assaying and Metallurgy, afford to all students in these departments an excellent opportunity to pursue an extended course of reading in connection with their class work. The Library also contains the standard works in English and American Poetry, fiction,

biography and history, provided with especial view to the needs of Academic students. The following periodicals for the current year are found on the reading tables of the Library.

American Chemical Journal,	Judge,
American Journal of Science,	Ladies' Home Journal,
American Journal of Philology,	Leslie's Illustrated Weekly,
American Geologist,	Life,
American Institute of Elec-	Literary Digest,
trical Engineering,	Lippincott,
Annales Des Mines,	Magazine of American His-
Atlantic Monthly,	tory.
Annalls of Mathematics,	Nation,
Century Magazine,	North American Review,
Electrical World,	Philosophical Review,
Electrical Engineer,	Popular Science Monthly,
Engineering Magazine,	Popular Science News,
Engineering News,	Public Opinion,
Engineering & Mining Journal,	Puck,
Forum,	Railroad & Engineering Journal,
Harper's Monthly,	Scribner's Magazine,
Harper's Weekly,	Scientific American Supple-
Illustrated London News,	ment.
Journal of Analytical and Applied Chemistry.	

The Library is open daily from 8 A. M. to 4 P. M. Books may be taken out of the Library by the students under certain regulations.

ATHLETICS.

Through the liberality of the Curators, an athletic field has been enclosed and graded for the benefit of the students. It furnishes ample space for base-ball, foot-ball and lawn tennis. An Athletic Association exists among the students, and, it is hoped that means will soon be provided for the erection of a Gymnasium.

LITERARY SOCIETIES.

Two literary societies have been organized—the Philo Literary Society by the young men, and the Alpha Club by the young woman of the School. They hold weekly meetings for the purpose of improvement in debate, oratory and composition. The “Alpha” meets every Saturday afternoon and the “Philo” every Saturday evening.

TERMS AND VACATIONS.

The college year is divided into two terms of eighteen weeks each. The first term begins on the third Tuesday in September, and ends about February 1. A ten days' vacation is given during the holidays to include Christmas and New Year. There is no interval between the ending of the first term and the beginning of the second. The second term ends on Commencement Day, which is the second Thursday in June. The summer vacation extends from Commencement to the beginning of school in September.

TERM EXAMINATIONS.

During the last week of each term all students are required to stand written examinations on the studies pursued, and the results of these examinations, with the average monthly grades, determine their term grades. A student, to pass, must attain at least 75 per cent. Daily oral and occasionally written examinations are held during the term, both for the enlightenment of professor and student and for the purpose of checking the results of the term examinations.

MONTHLY REPORTS.

Regular monthly reports are sent to the parents or guardian of each student, showing the student's grade in scholarship for the month and giving such other information in regard

to his progress, attendance, etc., as may be thought to be of interest. The attention of parents and guardians is particularly called to these reports.

DEGREES.

UNTITLED DEGREES.

1. A Certificate of Proficiency is conferred on one who has attained the required standard in any of the following special courses: Geology, Mineralogy, Inorganic Chemistry, Assaying, Electricity and Surveying.

2. A Diploma of Graduation is conferred on one who has attained the required standard in any of the following departments: Mathematics, Physics, Analytical Chemistry, Engineering and the Academic Course.

DEGREES WITH TITLES.

1. The degree of *Bachelor of Science in Mathematics and Physics* is conferred upon one who has attained the required standard on all of the subjects of instruction in the course of Mathematics and Physics.

2. The degree of *Bachelor of Science in Chemistry* is conferred on one who has attained the required standard on all of the work of the special Chemical Course.

3. The degree of *Bachelor of Science in Civil Engineering* is conferred on one who has attained the required standard on all of the subjects of instruction in the Civil Engineering Course.

4. The degree of *Bachelor of Science in Mining Engineering* is conferred on one who has attained the required standard on all of the subjects of instructions in the Mining Engineering Course.

5. The degree of *Bachelor of Science in Mathematical Engineering* is conferred on one who has attained the required standard on all of the subjects of the Mechanical Engineering

6. The degree of *Civil Engineer*, *Mining Engineer* or *Mechanical Engineer* is conferred on one who, having graduated in Civil, Mining or Mechanical Engineering and received the Bachelor's Degree therein, has identified himself with the profession during a period of not less than three years, and during that time has demonstrated by work his fitness for his chosen profession.

COMMENCEMENT.

The annual Commencement exercises are held in the Assembly room, at the close of the work in June. The exercises consist of an address by some prominent speaker, the conferring of the degree and granting of diplomas by the Director, and the reading of abstracts of their theses by members of the graduating class.

At the Commencement exercises on Thursday, June 9, 1892, the address was delivered by Dr. R. H. Jesse, President of the University.

The following is a list of the Graduates and the degrees conferred:

GRADUATES.

Mining Engineering, F. A. Jones.
Civil Engineering, F. A. Jones, F. L. Tyrrell.
Analytic Chemistry, D. C. Jackling, F. A. Jones.
Assaying, D. C. Jackling.

DEGREES.

Bachelor of Science (in Chemistry), D. C. Jackling,
E. M. Johnson.
Civil Engineer, F. A. Jones, F. L. Tyrrell.
Mining Engineer, F. A. Jones.

Graduates.

1874.

Gustavus A. Duncan, C. E.—Mining and Mine Examination.
Malden, Mass.

*John Holt Gill, C. E.—Died, June 14, 1882.

John Wallace Pack, M. E.—Assayer U. S. Mint, San Francisco, Cal.

1875.

*Francis J. Deegan, C. E.—Died, 1892.

Almon Warner Hare, M. E.—Chemist and Assayer, P. O.
Box 318, Aspen, Colo.

1876.

Cyrus H. Emerson, C. E.

Oscar E. Garvens, M. E.

John D. Greason, M. E.

John Edward McGrath, C. E., M. A.—Assistant U. S. Coast
Survey, Sitka, Alaska.

William C. Minger, M. E.—Chemist and Assayer, Georgetown,
Colo.

1877.

A. H. Ohmann-Dumesnil, M. E., A. M., M. D.—Physician
and Author, 1, N. Broadway, St. Louis, Mo.

Thomas H. Milsaps, C. E.

James Alexander Pack, M. E.—Mining Engineer, DeLamar,
Idaho.

1878.

William Y. Bean, C. E.

Wilton Rutherford Brown, M. E.—Assayer Hidalgo Mining
Co., Parral, Chihuahua, Mex.

Lindsay L. Coppedge, C. E.—Died, 1885.

Lee R. Grabill, M. E.

1879.

Rudolph C. Hoyer, C. E.—Draughtsman U. S. Engineer's Office, Memphis, Tenn.

Charles F. Winters, M. E.—Teller, Los Angeles Nat. Bank, 129, N. Olive St., Los Angeles, Cal.

1880.

Arthur Carson, M. E.—Chemist and Assayer, Butte City, Mont.

Lorin X. Smith, M. E., C. E.—Rolla, Mo.

1881.

Edward B. Summers, C. E.—With King Iron Bridge Co., 1625, Madison Ave., New York.

Walter W. Wishon, M. E.—Chief Chemist, Montana Ore Purchasing Co., 41 E. Park St., Butte City, Mont..

1882.

Frank W. Gibb, C. E., M. E.—Mining Engineer and Chemist, Member American Institute Mining Engineers, Little Rock, Ark.

W. R. Painter, C. E.—Attorney at Law, Carrollton, Mo.

Beauregard Ross, M. E.—Editor *The Sun*, Cameron, Mo.

Ashnah B. Schrantz, C. E.

Herman Neff Van Devander, C. E.—Secretary and Treasurer North Georgia Mining Co., Cedartown, Ga.

1883.

Floyd Davis, C. E., M. E., Ph. D.—Dean of the Iowa College of Pharmacy, Des Moines, Iowa.

1884.

Curtis Alexander, C. E., M. E.—Chief Assayer of Consolidated Kansas City Smelting and Refining Co., Argentine, Kan.

William M. Claypool, C. E., M. E.

Arthur Neustaedter, M. E.—Chemist and Assayer, Butte City, Mont.

Philip C. Gallagher, M. E.—Miner, Creede, Colo.

Frank W. Wilson, C. E.—Contracting Agent King Iron Bridge Co., 18 Broadway, New York, N. Y.

1885.

John R. D. Owen, M. E.—Died.

Philip R. Van Frank, M. E.—Transitman U. S. River Commission, Little Rock, Ark.

Fremont W. Wilson, C. E.

1886.

Jay Cullens, C. E.

James E. Fulcher, C. E.—Professor Natural Science and Mathematics, McCune College, Louisiana, Mo.

Justo S. Martinez, M. E.

1887.

George W. Cole, C. E.—Second Lieutenant Seventh Cavalry, U. S. A. Ft. Riley, Kan.

Oscar Lachmund, M. E.—Assayer and Chemist for Idaho Sampling Works, Idaho Springs, Colo.

W. Merritt Yeater, M. E.—Civil Engineer, Sedalia, Mo.

George B. Miles, C. E.—With St. Louis Bridge and Iron Co., St. Louis, Mo.

1890.

George Reginald Dean, C. E.—See 1891.

1891.

George Reginald Dean, C. E., B. Sc.—Assistant in the Leander McCormick Observatory, University of Va., Charlottesville, Va.

Sallie Elizabeth Millard, B. Sc.—Post Graduate Missouri School of Mines, Rolla.

Frank H. Seaman, M. E.—Chemist and Assayer Vacas Mining and Smelting Co., Mina de Vacas, Estado de Durango, Mexico.

Arthur J. Stewart, B. Sc.—Assistant Superintendent Notolino Mining Co., La Noria, State of Zacatecas, Mexico.

1892.

Daniel C. Jackling, B. Sc.—Assistant in Department of Chemistry, Missouri School of Mines, Rolla, Mo.

Edward Mackay Johnson, B. Sc.—With Kansas City Smelting and Refining Co., Argentine, Kan.

Fayette A. Jones, C. E., M. E.—Mining Engineer and Assayer for Union Mining Co., Phœnix, Ariz.

Frank L. Tyrrell, C. E.—Post Graduate Student in Mining Engineering Missouri School of Mines.

OTHERS WHO PURSUED SPECIAL COURSES.

James L. Buskett.—Assayer and Chemist for Boulder Smelting Co., Boulder, Mont.

Louis W. Buskett.—Assayer Nine Mile Mining Co., Martina, Mont.

William Patton Holman.—Professor of Mathematics, State School of Mines, Rapid City, S. D.

Catalogue of Students.

POST-GRADUATES.

Johnson, Edward Mackay, B. Sc.,	-	-	Argentine, Kan.
Millard, Sallie Elizabeth, B. Sc.,	-	-	Rolla.
Tyrrell, Frank Lee, C. E.,	-	-	Sinkin.

UNDER-GRADUATES.

Alexander, George Ernest,	-	-	-	-	Maryville.
Anderson, Perry Barton,	-	-	-	-	Neosho.
Bradford, Robert Edward Lee,	-	-	-	-	Edgar Springs.
Branson, Charles Sylvester,	-	-	-	-	Byron.
Branson, Dennis Sydney,	-	-	-	-	Byron.
Brewster, James Madison,	-	-	-	-	Macedonia.
Buskett, Mary Page,	-	-	-	-	Rolla.
Campbell, Eugene,	-	-	-	-	Rolla.
Cansler, Gussie Kathryn,	-	-	-	-	Rolla.
Case, Allen Bertley,	-	-	-	-	Lecoma.
Clark, Charles Frederick,	-	-	-	-	Lebanon.
Cleino, Charles Conrad,	-	-	-	-	Rolla.
Connelly, George Joseph,	-	-	-	-	Denver, Col.
Cook, Edwin Wallace,	-	-	-	-	Competition.
Corse, Lottie Edith,	-	-	-	-	Rolla.
Cowen, Herman Cyril,	-	-	-	-	Bethany.
Dean, George Walter,	-	-	-	-	Rolla.
Deegan, Agnes Julian,	-	-	-	-	Rolla.
DeLay, Theodore Stuart,	-	-	-	-	Creston, Iowa.
Dilworth, William,	-	-	-	-	Salem.
Donnan, David McAnally,	-	-	-	-	Elk Prairie.
Donnelly, Arthur,	-	-	-	-	Lebanon.
Donnelly, Sophia Mary,	-	-	-	-	Lebanon.
Dwyer, Edward,	-	-	-	-	Joplin.

Dyer, Temple, - - - - -	Rolla.
Flett, James Cyrus, - - - - -	Salem.
Florreich, Philip, - - - - -	St. Louis.
Flynn, Frank Nicholas, - - - - -	Denver, Col.
Freeman, Edna Josephine, - - - - -	Relfe.
Germann, Frank Arthur, - - - - -	Rolla.
Gilbert, Richard William, - - - - -	Rolla.
Godwin, Annie Gill, - - - - -	Rolla.
Gormly, Samuel James, - - - - -	Mt. Vernon, Iowa.
Grove, Claude Devlin, - - - - -	Gallatin.
Guenther, Eda Minnie, - - - - -	Rolla.
Hardin, Eva Augusta, - - - - -	Rolla.
Harper, William, Joseph, - - - - -	Parsons, Kan.
Harris, Walter Bibb, - - - - -	Melbourne, Ark.
Harty, Bruce Arthur, - - - - -	Stoutland.
Hawkins, Philip Cordell, - - - - -	Brumley.
*Henderson, Harry Philip, - - - - -	St. James.
Henry, David Edward, - - - - -	Pleasant, Ind.
Hitch, Arthur Martin, - - - - -	Cuba.
Hogan, Charles William, - - - - -	Lebanon.
Hogan, Josie, - - - - -	St. James.
Hollow, Henry Orlando, - - - - -	Cuba.
Hubbert, Guy, - - - - -	Neosho.
Hughes, Richard Kingston, - - - - -	Neosho.
Iijima, Zentaro, - - - - -	Saitamaken, Japan.
Irick, James Albert, - - - - -	Competition.
Jamison, Blanche, - - - - -	Rolla.
Kennedy, William Price, - - - - -	Rolla.
Kerr, William Christian, - - - - -	St. Louis.
Kilgore, Josephine, - - - - -	Rolla.
Knapp, Margaret Ann, - - - - -	Relfe.
Lepper, Anna May, - - - - -	Rolla.
Lepper, Jennie Edith, - - - - -	Rolla.
LeSueur, Ellen Virginia, - - - - -	Edgar Springs.
Lewis, Lillian Jeanette, - - - - -	St. Louis.
Livingston, Archibald Armstrong, - - - - -	Elk Prairie.
McCaw, Margaret, - - - - -	Rolla.

*Died December 10, 1892.

McCracken, Lucy Ellen,	- - - - -	Rolla.
McMullin, Richard Willie,	- - - - -	Hillsboro.
Madigan, Emma Rose,	- - - - -	Rolla.
Madigan, Fannie May,	- - - - -	Rolla.
Maness, George Sherman,	- - - - -	Rolla.
Martin, Grace,	- - - - -	Sullivan.
Meriwether, Carl,	- - - - -	Rolla.
Millard, Linna,	- - - - -	Rolla.
Miller, Margaret,	- - - - -	Crocker.
Mitchel, Peter Reuben,	- - - - -	Bakersfield.
Mitchell, Walter,	- - - - -	Rolla.
Morgan, Minnie,	- - - - -	Rolla.
Morris, Fanny Brown,	- - - - -	Rolla.
Morris, Lola,	- - - - -	Rolla.
Oatley, John Arthur,	- - - - -	Rolla.
Phariss, Ida,	- - - - -	Rolla.
Petraglio, Ama,	- - - - -	Rolla.
Ponder, Abram Russell,	- - - - -	Chehalis, Wash.
Reid, John Calum,	- - - - -	Pleasanton, Kas.
Richardson, Ethelyn Anne,	- - - - -	Rolla.
Richardson, Grace Serepta,	- - - - -	Rolla.
Robertson, George Gordon,	- - - - -	Cuba.
Rolufs, Rulof Theodore,	- - - - -	Vest.
Rowe, Catherine,	- - - - -	Rolla.
Sappenfield, Estella Aurora,	- - - - -	Rolla.
Sappenfield, Olive,	- - - - -	Rolla.
Seay, Clifford Edward,	- - - - -	Salem.
Sharrar, May Dora,	- - - - -	Rolla.
Shaw, Olive Helen,	- - - - -	Rolla.
Smith, Tennie Estelle,	- - - - -	Rolla.
Soest, Adele,	- - - - -	Rolla.
Southgate, Margaret Barron,	- - - - -	Rolla.
Spencer, Clifton Bates,	- - - - -	Joplin.
Spencer, Herbert Galen,	- - - - -	Joplin.
Stephenson, Lulu Elizabeth,	- - - - -	Rolla.
Suppan, Leo Richard August,	- - - - -	St. Louis.
Tallman, Blanche,	- - - - -	Crocker.
Thomas, William Stephens,	- - - - -	Bevier.

Thompson, Frederick Lewis,	- - - -	Rolla.
Torrence, Leslie Clay,	- - - - -	Pocahontas.
Vaughan, Robert Edward Lee,	- - -	Salem.
Via, Jessie Miller,	- - - - -	Rolla.
Walker, Jennie.	- - - - -	Rolla.
Walker, John Edward,	- - - - -	Vichy.
Watson, John Adolph,	- - - - -	Safe.
Weisenbach, Addie Marguerite,	- - -	Rolla.
Weissgerber, Otto,	- - - - -	Lebanon.
Wendt, Francis Eugene,	- - - - -	St. James.
Whitley, Minnie,	- - - - -	Rolla.
Wilkins, Elinor Matilda,	- - - - -	Rolla.
Wood, Arthur Edward,	- - - - -	Rolla.
Zelch, John Albert,	- - - - -	Clayton.

Total, 116.





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